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100450

17 September 1993

Ms. Katherine Lose  
U.S. Environmental Protection Agency  
Region III  
841 Chestnut Street Building, 3HW25  
Philadelphia, PA 19107

RE: Draft Bioremediation Treatability Testing Program Summary of Findings  
Standard Chlorine, Delaware City Facility

Dear Ms. Lose:

Enclosed please find five copies of the Draft Bioremediation Treatability Testing Program Summary of Findings submitted by Roy F. Weston, Inc. on behalf of Standard Chlorine of Delaware, Inc., for the RI/FS program being conducted at the referenced site.

If you have any questions or comments, please do not hesitate to contact us.

Very truly yours,

ROY F. WESTON, INC.

Michael F. Kress, P.E.  
Project Engineer

MFK/mk  
Enclosures

cc: Robert Touhey  
Paul Johnston  
Abraham Thomas  
Thomas Drew  
Michael Corbin

AR308299

# **DRAFT**

## **BIOREMEDIATION TREATABILITY TESTING PROGRAM SUMMARY OF FINDINGS**

**Standard Chlorine of Delaware, Inc.  
Delaware City, Delaware**

**September 1993**

**Prepared by**

**Roy F. Weston, Inc.  
1 Weston Way  
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**AR308300**

<u>Section</u>	<u>Title</u>	<u>Page</u>
1.0	Overview	1
2.0	Test Plans	2
3.0	Sample Collection	3
4.0	Sample Characterization Results	6
5.0	Experimental Design	7
6.0	Experimental Procedures	8
6.1	General	8
6.2	Aerobic Flask Tests	9
6.3	Anaerobic Flask Tests	10
6.4	Soil Column Tests	11
7.0	Results	13
8.0	Findings	14
8.1	Surface Soil	14
8.2	Subsurface Soil	14
8.3	Sediment	15
8.4	All Soils	15
9.0	Conclusions	16

**LIST OF ATTACHMENTS**

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- 1        Treatability Study Sample Locations**
- 2        Chlorobenzene Characterization Results for Field Samples\***
- 3        Geotechnical/Physical Characterization Results for Treatability Study Samples\***
- 4        Test Matrix for Flask Studies**
- 5        Test Matrix for Column Studies**
- 6        Soil Column Test Apparatus Schematic**
- 7        Chlorobenzene Results for Individual Samples\***
- 8        Chloride and Nutrient Results\***
- 9        Tabular Results Summaries\***
- 10       Graphical Results Summaries**

**\* Not included in draft submittal of 17 September 1993, will be included in an addendum to the FS.**

**AR308302**

**1.0 OVERVIEW**

- 1.1 A bioremediation treatability study was conducted by Roy F. Weston, Inc. (WESTON®) for Standard Chlorine of Delaware, Inc. (SCD) in accordance with WESTON's December 1992 Work Plan.
- 1.2 The objective of the study was to evaluate the technical feasibility of bioremediation for the treatment of soils containing chlorobenzenes at the SCD, Delaware City, Delaware facility.
- 1.3 The treatability study consisted of a bench-scale screening program which included a series of aerobic and anaerobic flask tests as well as soil column tests.
- 1.4 The treatability study was conducted at WESTON's Environmental Technology Laboratory (ETL) in Lionville, Pennsylvania from February through May 1993.
- 1.5 Analyses of treatability study samples for chlorobenzenes was performed by the SCD laboratory at the Delaware City facility.
- 1.6 Analyses of treatability study samples for chloride, and nitrogen and phosphorus compounds was performed by WESTON's Analytical Laboratory in Lionville, Pennsylvania.
- 1.7 Geotechnical/physical characterization of the soil samples used in the treatability study was performed by WESTON's ETL.

**2.0 TEST PLANS**

- 2.1 The technical approach and scope of the treatability study was developed in accordance with WESTON's discussions at meetings with SCD, DNREC and EPA.
- 2.2 A preliminary test plan for the treatability study is provided in WESTON's proposal to SCD dated 18 November 1992.
- 2.3 A detailed test plan for the treatability study is presented in WESTON's "Draft Work Plan for Bioremediation Treatability Testing for the Standard Chlorine of Delaware, Inc. Delaware City, DE Site" dated December 1992. This plan was submitted to DNREC and EPA for review and comment.
- 2.4 The Health and Safety Plan used for sample collection and treatability testing was the approved plan used for the RI.
- 2.5 The Quality Assurance Project Plan used for the sampling and analysis activities was the approved plan used for the RI.

**3.0 SAMPLE COLLECTION**

- 3.1 Samples of the surface soil, subsurface soil, and sediment for use in the treatability study were collected from the SCD Delaware City facility by WESTON personnel on 7 January 1993. Since the subsurface soil samples collected on 7 January 1993 did not contain chlorobenzenes at the targeted concentrations, additional subsurface samples were collected by WESTON personnel on 25 January 1993.
- 3.2 All WESTON sampling activities were conducted in Level D.
- 3.3 The locations of the treatability study samples are indicated on the map provided in Attachment 1 (Figure 1).
- 3.4 The three surface soil samples collected on 7 January 1993 were designated SS-1-1, SS-1-2, and SS-1-3. Each sample was collected from a discrete location in the vicinity of RI Sample SS-19. The samples were collected manually from the 0 to 6 inch depth.
- 3.5 The three sediment samples collected on 7 January 1993 were designated SD-1-1, SD-1-2, and SD-1-3. Each sample was collected from a discrete location in the vicinity of RI Sample SSX-11. The samples were collected manually from the 0 to 6 inch depth. Leaves and vegetation were scraped off the top of the sediment prior to sample collection.
- 3.6 The three subsurface soil samples collected on 7 January 1993 were designated SBS-1-1, SBS-1-2, and SBS-1-3. Each sample was collected from a discrete location within a test pit dug in the vicinity of RI Sample SS-31. The samples were collected using a backhoe from a depth of approximately 4 feet.

- 3.7 The two subsurface soil samples collected on 25 January 1993 were designated SBS-1-1 and SBS-2-1. Sample SBS-1-1 was collected from a discrete location within a test pit dug directly north of the railroad tracks. This sample was collected using a backhoe from a depth of 5 to 6 feet. Sample SBS-2-1 was collected from a discrete location within a test pit dug in the vicinity of the benzene tanks. This sample was collected using a backhoe from a depth of approximately 4 feet.
- 3.8 All samples were collected using decontaminated sampling tools (including the backhoe bucket).
- 3.9 All samples were screened in the field through a 1/4-inch sieve prior to placement in buckets and sample containers.
- 3.10 Each surface soil and sediment sample consisted of two, 3.5-gallon plastic buckets (one for aerobic tests and one for anaerobic tests). One bucket (to be used for anaerobic tests) was purged with nitrogen prior to sealing. Additionally, one, 125 mL VOA bottle and one, 950-mL amber glass bottle was filled with sample and submitted to the SCD laboratory for chlorobenzenes analysis.
- 3.11 Each subsurface soil sample consisted of two, 3.5-gallon plastic buckets (one for aerobic tests and one for anaerobic tests) and two, 5-gallon plastic buckets (for column tests). One 3.5-gallon bucket (to be used for anaerobic tests) and both 5-gallon buckets were purged with nitrogen prior to sealing. One undisturbed tube sample was also collected from each subsurface soil location. Additionally, one, 125-mL VOA bottle and one, 950-mL amber glass bottle was filled with sample and submitted to the SCD laboratory for chlorobenzenes analysis.
- 3.12 Chain-of-Custody documentation was completed for all samples.

- 3.13 Following collection, the bulk samples were transported to WESTON's ETL and stored under refrigeration (4°C) until they were used for treatability testing.

**4.0 SAMPLE CHARACTERIZATION RESULTS**

- 4.1 The results of chlorobenzenes analyses for the surface soil, subsurface soil, and sediment samples collected on 7 and 25 January 1993 are summarized in tabular form in Attachment 2.
- 4.2 Based on the total chlorobenzene (TotCB) concentrations measured, the following samples were selected for use in the treatability study:
- Surface soil - Sample SS-1-3 (1/7/93), TotCB = 5,370 mg/kg
  - Subsurface soil - Sample SBS-1-1 (1/25/93), TotCB = 1,080 mg/kg
  - Sediment - Sample SD-1-3 (1/7/93), TotCB = 190 mg/kg
- 4.3 The results of geotechnical/physical testing conducted on the three treatability study samples are presented in Attachment 3.

## 5.0 EXPERIMENTAL DESIGN

5.1 The bench-scale bioremediation study consisted of the following elements:

- Aerobic flask tests
- Anaerobic flask tests
- Soil column tests

5.2 Aerobic and anaerobic flask tests were conducted for the surface soil, subsurface soil, and sediment samples using three treatment conditions - inhibited control, nutrient amended, and nutrient amended/inoculated. For each treatment condition, a series of triplicate flasks were set up for analysis of samples at Day 0, 10, 30, and 60 of the test period.

5.3 A summary of the test matrix for the flask studies for chlorinated benzene and chloride/nutrient analyses is provided in Attachment 4, Tables 1 and 2.

5.4 Soil column tests were conducted for the subsurface soil sample only. The tests were conducted under anaerobic conditions using two soil columns - control column and nutrient column. For each column, triplicate soil and water feed samples were collected at Day 0 and Day 60 of the test period and triplicate column leachate samples were collected at Day 0, 10, 30, and 60 of the test period.

5.5 A summary of the test matrix for the column studies for chlorinated benzene and chloride/nutrient analyses is provided in Attachment 5, Tables 1 and 2.

5.7 The initiation of the flask tests was staggered over a period of 6 weeks to more evenly distribute the sample loading to the SCD laboratory.

## 6.0 **EXPERIMENTAL PROCEDURES**

### 6.1 **General**

- 6.1.1 All treatability tests were conducted at room temperature (approximately 70°F).
- 6.1.2 The flasks for the aerobic tests were exposed to ambient building lighting during the course of the study.
- 6.1.3 The flasks for the anaerobic tests and the soil columns were isolated from ambient building lighting during the course of the study. The anaerobic flasks were placed inside a box and the columns were wrapped in aluminum foil.
- 6.1.4 Nutrient addition to the flasks and columns was targeted to provide an initial carbon:nitrogen weight ratio of 1:0.05.
- 6.1.5 At the required sampling interval (i.e., Day 0, 10, 30, and 60), the soil slurry contained in the aerobic and anaerobic test flasks was transferred to sample containers for analysis as follows:
- Chlorobenzenes - 100 mL, glass bottle; cool
  - Chloride and O-PO<sub>4</sub> - 125 mL, plastic bottle; cool
  - Nitrogen compounds and T-PO<sub>4</sub> - 500 mL, plastic bottle; H<sub>2</sub>SO<sub>4</sub>/cool
- 6.1.6 At the required sampling interval (i.e., Day 0, 10, 30, and 60), the soil, water feed, and column leachate samples from the column tests were collected for analysis in the following containers:
- Chlorobenzenes in soil - 500 mL, glass bottle ; cool

- Chlorobenzenes in feed/leachate - 950 mL amber, glass bottle; cool and two, 40 mL VOA bottles; cool
- Chloride and O-PO<sub>4</sub> in feed/leachate - 125 mL, plastic bottle; cool
- Nitrogen compounds and T-PO<sub>4</sub> in feed/leachate - 125 mL, plastic bottle; H<sub>2</sub>SO<sub>4</sub>/cool

6.1.7 Following collection of the treatability study samples, they were packed in a cooler containing ice. Chain-of-Custody forms were completed and the samples were then transported to the analytical laboratory. Samples for chlorobenzenes analyses were delivered to the SCD laboratory by WESTON personnel or by a commercial courier service. Samples for chloride and nutrient analyses were delivered to the WESTON Lionville Analytical Laboratory by WESTON personnel.

## 6.2 Aerobic Flask Tests

- 6.2.1 The aerobic test flasks consisted of 250 mL, glass Erlenmeyer flasks containing approximately 100 mL (100 g) of soil slurry.
- 6.2.2 The slurry in the flasks was approximately 20% by weight soil in water.
- 6.2.3 The prepared flasks were placed on a shaker table and continuously agitated. Agitation provided for oxygenation and mixing of the soil slurry. The flasks were loosely covered with plastic caps to minimize evaporation losses.
- 6.2.4 The soil slurry for the control flasks of the aerobic tests was prepared by mixing the soil/sediment sample with fertilizer solution, formaldehyde (37%), and medium solution. The fertilizer solution consisted of either commercial fertilizer (20:20:20) or (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub>. The medium solution contained KH<sub>2</sub>PO<sub>4</sub>, NaHPOH, and Resazurin. Resazurin is a redox indicator which is pink in the presence of oxygen and blue when oxygen is not present. All solutions were prepared using deionized water.

6.2.5 The soil slurry for the nutrient flasks of the aerobic tests was prepared by mixing the soil/sediment sample with fertilizer and medium solutions. These solutions were identical to those described in Item 6.2.4.

6.2.6 The soil slurry for the nutrient/inoculated flasks of the aerobic tests was prepared by mixing the soil/sediment sample with fertilizer solution, sludge inoculum, and medium solution. The fertilizer and medium solutions were identical to those described in Item 6.2.4. The sludge inoculum consisted of washed secondary activated sludge obtained from the aeration tank of the Goose Creek Wastewater Treatment Plant in West Chester, Pennsylvania.

### 6.3 Anaerobic Flask Tests

6.3.1 The anaerobic test flasks consisted of 125 mL, glass serum bottles containing approximately 100 mL (100 g) of soil slurry.

6.3.2 The slurry in the serum bottles was approximately 50% by weight soil in water.

6.3.3 The prepared serum bottles were purged with nitrogen, tightly sealed, and placed inside a box. The bottles were occasionally shaken by hand to mix the contents.

6.3.4 The soil slurry for the control flasks of the anaerobic tests was prepared by mixing the soil/sediment sample with fertilizer solution, formaldehyde (37%), and medium solution. The fertilizer and medium solutions were identical to those described in Item 6.2.4.

6.3.5 The soil slurry for the nutrient flasks of the anaerobic tests was prepared by mixing the soil/sediment sample with fertilizer and medium solutions. These solutions were identical to those described in Item 6.2.4.

6.3.6 The soil slurry for the nutrient/inoculated flasks of the anaerobic tests was prepared by mixing the soil/sediment sample with fertilizer solution, sludge inoculum, and medium solution. The fertilizer and medium solutions were identical to those described in Item 6.2.4. The sludge inoculum consisted of washed anaerobic sludge obtained from the anaerobic digester of the West Goshen Wastewater Treatment Plant in West Chester, Pennsylvania.

#### 6.4 Soil Column Tests

6.4.1 The soil column tests used glass columns (4-inch diameter by 4-feet long) containing approximately 12.5 kg of subsurface soil sample compacted to a height of 3 feet (equivalent to the measured in place soil density).

6.4.2 The prepared soil columns were mounted on a rack and covered with aluminum foil to prevent exposure to light.

6.4.3 A schematic of the soil column test apparatus is provided in Attachment 6.

6.4.4 The feed water was added to columns on a continuous basis such that the soil was completely saturated with water and a standing water layer filled the top of the column.

6.4.5 The feed water for the control column consisted of tap water which was adjusted to pH 6.3 (i.e., pH of site groundwater) and de-oxygenated by the addition of sodium sulfite ( $\text{Na}_2\text{SO}_3$ ).

6.4.6 The feed water for the nutrient column was identical to the control column with the addition of a nutrient solution containing  $(\text{NH}_4)_2\text{PO}_4$ .

- 6.4.7 The equivalent 10-year leachate volume calculated for the column study was approximately 1,750 gallons.
- 6.4.8 The soil samples collected from the columns at the beginning and end of the study represent a composite sample of the entire contents of the column.

**7.0 RESULTS**

- 7.1 The chlorobenzene data for the individual samples from the treatability study are summarized in tabular form in Attachment 7.
- 7.2 The chloride and nutrient data from the treatability study are summarized in tabular form in Attachment 8.
- 7.3 Tabular summaries of the data for results interpretation are provided in Attachment 9.
- 7.4 Graphical summaries of the data for results interpretation are provided in Attachment 10.

## **8.0 FINDINGS**

### **8.1 Surface Soil**

- 8.1.1 All aerobic samples showed a significant initial reduction in total chlorinated benzenes and total chloride during the first 10 days of treatment (see Attachment 10, Figure 2). The rate of reduction leveled off during the subsequent treatment (10 to 60 days).
- 8.1.2 The anaerobic control sample showed relatively constant total chlorinated benzenes and total chloride over the test duration (see Attachment 10, Figure 3).
- 8.1.3 The anaerobic nutrient and nutrient/inoculated samples showed a general reduction in total chlorinated benzenes and an increase in total chloride.

### **8.2 Subsurface Soil**

- 8.2.1 The aerobic nutrient and nutrient/inoculated samples showed a decrease in total chlorinated benzenes and a slight net increase in total chloride (see Attachment 10, Figure 4).
- 8.2.2 The aerobic control sample showed a slight net decrease of total chlorinated benzenes and total chloride over test duration.
- 8.2.3 The anaerobic control, nutrient and nutrient/inoculated samples showed a net increase in total chlorinated benzenes (see Attachment 10, Figure 5). All samples except the control sample showed an increase in total chloride.

**8.3 Sediment**

- 8.3.1 The aerobic control and nutrient samples show a net decrease in total chlorinated benzenes (see Attachment 10, Figure 6). The nutrient inoculated sample data is sporadic and shows no trend.
- 8.3.2 The anaerobic shows a net increase in total chlorinated benzenes for all samples, with little change in total chloride (see Attachment 10, Figure 7).

**8.4 All Soils**

- 8.4.1 Nutrient levels in the samples as measured by nitrogen and phosphorous remained essentially constant throughout the test period. Nutrient concentrations were sufficient to maintain and stimulate biological growth during the test period.

## 9.0 CONCLUSIONS

- 9.1 The anaerobic surface soil flask test exhibited presumptive evidence of biodegradation of chlorinated benzenes. This evidence is seen in the general declining trend in total chlorinated benzenes in conjunction with the consistent increase in chlorides in the nutrient and nutrient/inoculated flasks (see Attachment 10, Figure 3). By comparison, total chlorides in the control flask exhibited no substantial change during the course of the test. The production of chlorides, in conjunction with the declining levels of total chlorinated benzenes is presumptive evidence of dechlorination of chlorinated benzenes, and the absence of chloride production in the control flask suggests that the observed changes in the test flasks may be attributable to biological activity.

Dechlorination of the higher chlorinated benzenes would be expected to result in the production of lower chlorinated benzenes, which would then be further dechlorinated. However, this effect may have been masked in these tests by the pre-existing levels of lower chlorinated benzenes, as clearly discernable trends among chlorinated benzenes were not observed.

- 9.2 The aerobic subsurface soil flask test also exhibited presumptive evidence of dechlorination of chlorinated benzenes based on the combination of declining trends in total chlorinated benzenes and the net increase in total chlorides in the nutrient and nutrient/inoculated tests (see Attachment 10, Figure 5). By comparison, chlorides in the control flask exhibited some scatter, but no overall trend was observed. The possible contribution of stripping (as shown in other aerobic tests) to the total removal of chlorinated benzenes in this test should be noted, and, as a result, the contribution of biological activity to chlorinated benzene removal cannot be definitively evaluated.

- 9.3 The surface soil and sediment aerobic flask tests exhibited a high initial rate of total chlorinated benzene losses from the slurry-phase soil samples. The total chlorinated benzene losses are likely attributable to stripping rather than biodegradation since a concurrent increase in chloride levels was not measured. The stripping from the slurried soil samples may have been enhanced by the continuous stirring/agitation during the test period. Agitation was performed to maintain mixed aerobic conditions in the samples.

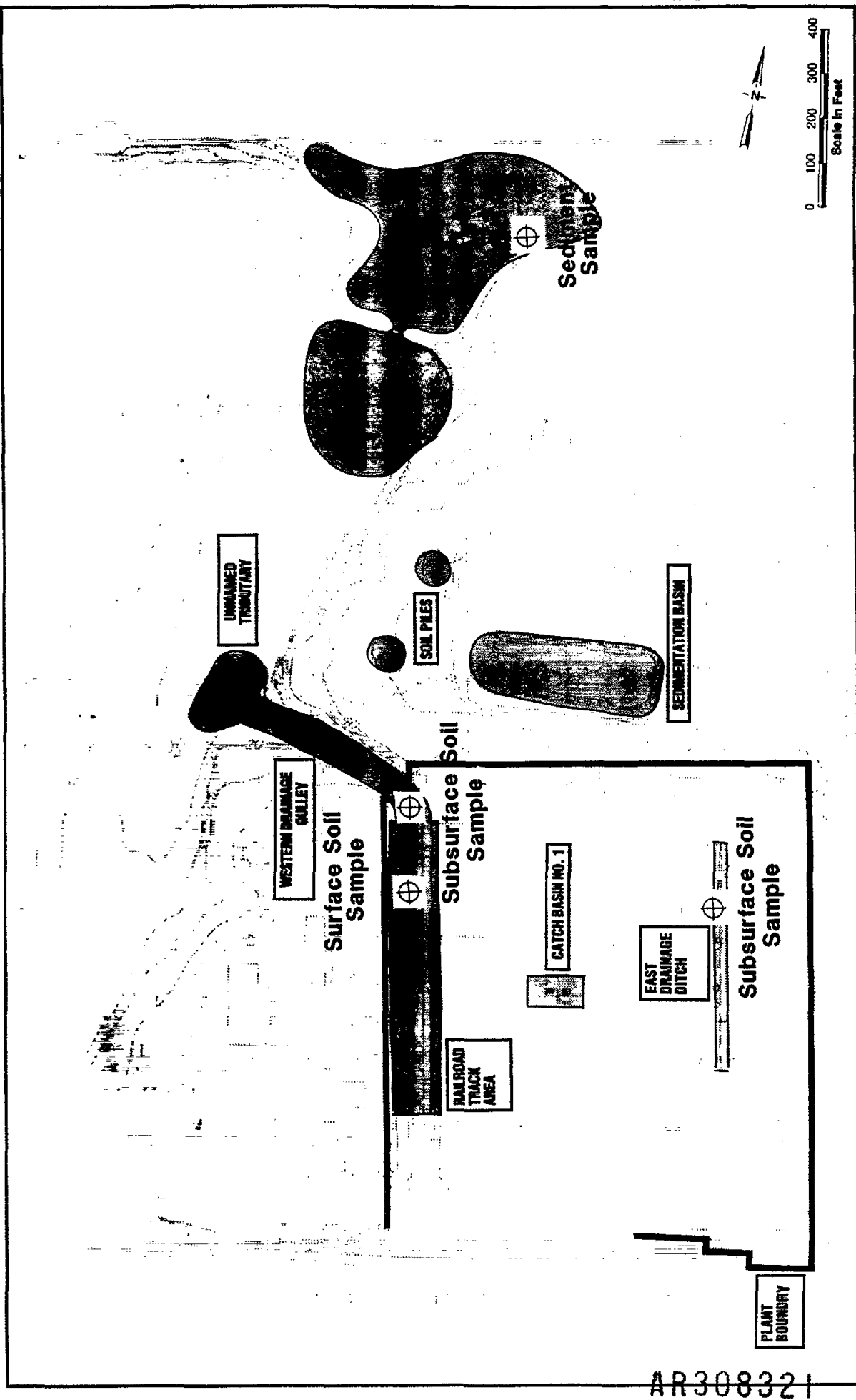
Because the treatability study was designed to test the biodegradability of the soils, the stripping effects encountered in the slurry-phase soils is not necessarily considered indicative of the strippability of in situ soils. In situ soils would not undergo agitation, and are present in the solid phase rather than a slurry phase. For these reasons, the findings of the study are not considered applicable to other treatment technologies such as soil vapor extraction.

- 9.4 Anaerobic soil column tests exhibited total chlorinated benzene losses from the soil which are likely due to flushing of soluble chlorobenzenes during testing. The concentration of total chlorinated benzene found in the aqueous leachate from the initial flushes through the column accounted for essentially all of the quantity of chlorobenzenes removed from the soil columns. Both the control and nutrient-enriched columns exhibited similar results during the column tests.
- 9.5 Additional process development testing would be necessary to expand the application of biodegradation to a wider range of soils and conditions; specifically towards application in the wetland areas. Nutrient addition in these areas may promote natural degradation of contaminants, as seen in the anaerobic surface soil and aerobic subsurface soil tests.

**ATTACHMENT 1**

**TREATABILITY STUDY SAMPLE LOCATIONS**

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FIGURE 1 SAMPLE LOCATIONS

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**ATTACHMENT 4**

**TEST MATRIX FOR FLASK STUDIES**

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ATTACHMENT 4  
TABLE 1  
FLASK TEST MATRIX: CHLOROBENZENE ANALYSES

SAMPLE	TEST TYPE	TEST CONDITION	MATRIX	NO. OF SAMPLES					TOTAL L
				DAY 0	DAY 10	DAY 30	DAY 60		
SURFACE SOIL	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
SUBSURFACE SOIL	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
SEDIMENT	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	3	3	3	3	12	
TOTAL			SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
			SOIL SLURRY	3	3	3	3	12	
				54	54	54	54	216	

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ATTACHMENT 4  
TABLE 2  
FLASK TEST MATRIX: CHLORIDE/NUTRIENT ANALYSES

SAMPLE	TEST TYPE	TEST CONDITION	MATRIX	NO. OF SAMPLES				
				DAY 0	DAY 10	DAY 30	DAY 60	TOTAL
SURFACE SOIL	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
SUBSURFACE SOIL	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
SEDIMENT	AEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
	ANAEROBIC	CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
TOTAL		CONTROL NUTRIENT NUTRIENT/INOCULATE D	SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			SOIL SLURRY	1	1	1	1	4
			18	18	18	18	72	

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**ATTACHMENT 5**

**TEST MATRIX FOR COLUMN STUDIES**

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ATTACHMENT 6  
TABLE 1  
COLUMN TEST MATRIX: CHLOROBENZENE ANALYSES

SAMPLE	TEST TYPE	TEST CONDITION	MATRIX	NO. OF SAMPLES				
				DAY 0	DAY 10	DAY 30	DAY 60	TOTAL L
SUBSURFACE SOIL	ANAEROBIC	CONTROL	SOIL WATER FEED COLUMN LEACHATE	3	0	0	3	6
				3	0	0	3	6
				3	3	3	3	12
		NUTRIENT	SOIL WATER FEED COLUMN LEACHATE	3	0	0	3	6
				3	0	0	3	6
				3	3	3	3	12
TOTAL				18	6	6	18	48

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ATTACHMENT 5  
TABLE 2  
COLUMN TEST MATRIX: CHLORIDE/NUTRIENT ANALYSES

SAMPLE	TEST TYPE	TEST CONDITION	MATRIX	NO. OF SAMPLES					TOTAL
				DAY 0	DAY 10	DAY 30	DAY 60		
SUBSURFACE SOIL	ANAEROBIC	CONTROL	SOIL	0	0	0	0	0	
			WATER FEED	1	0	0	1	2	
			COLUMN LEACHATE	1	1	1	1	4	
		NUTRIENT	SOIL	0	0	0	0	0	
WATER FEED	1		0	0	1	2			
COLUMN LEACHATE	1		1	1	1	4			
TOTAL				4	2	2	4	12	

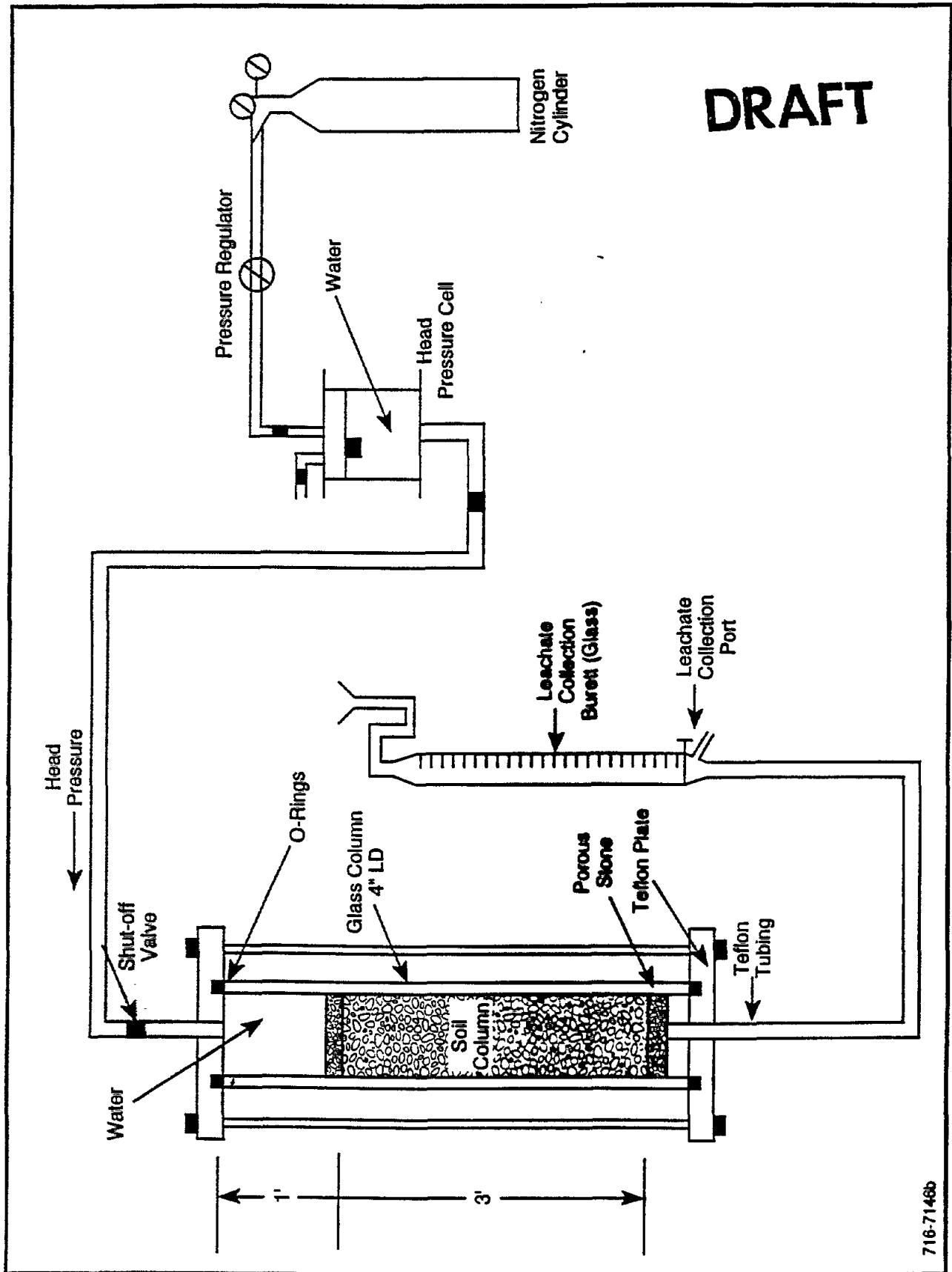
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**ATTACHMENT 6**

**SOIL COLUMN TEST APPARATUS SCHEMATIC**

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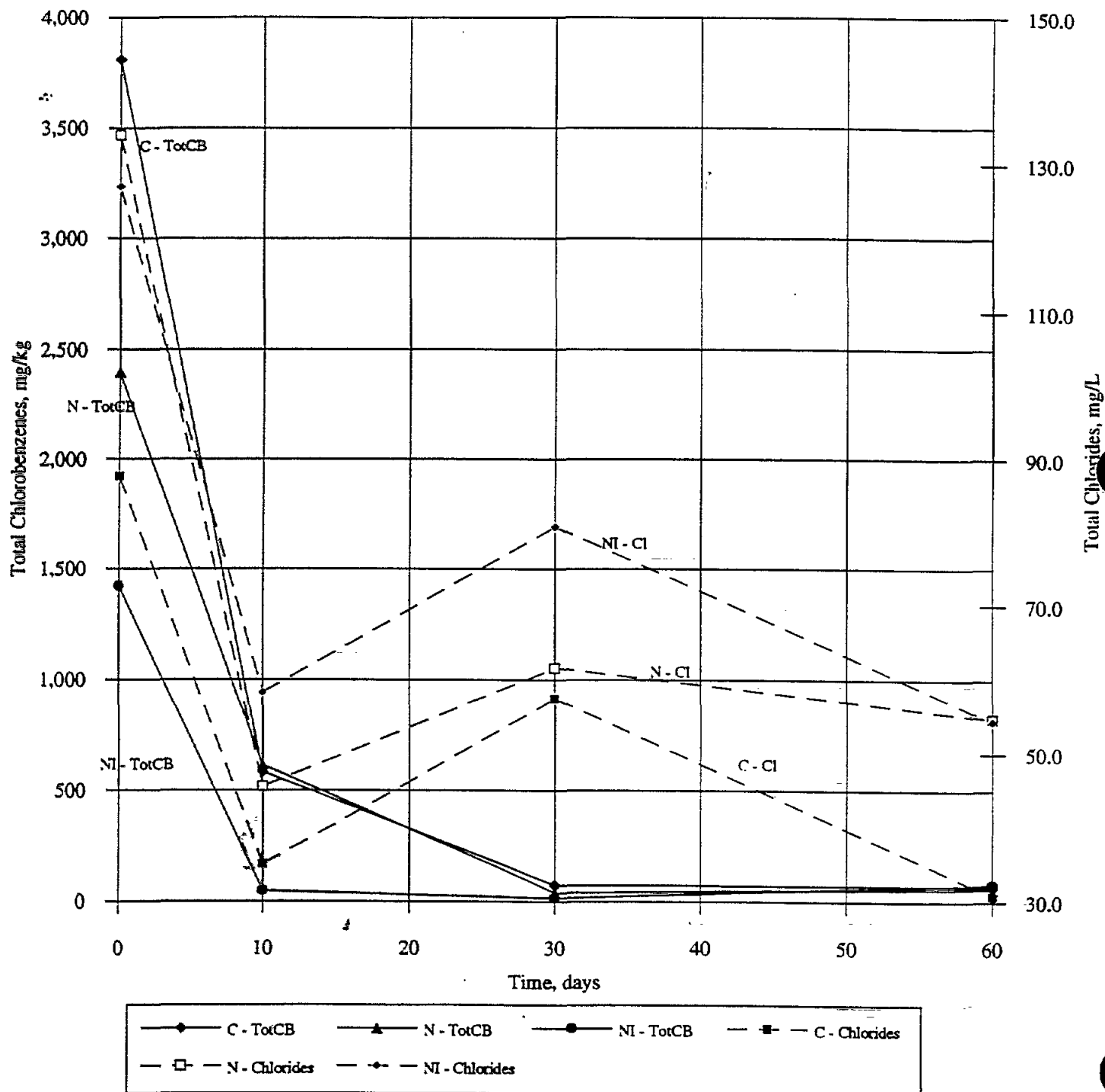
**ATTACHMENT 10**

**GRAPHICAL RESULTS SUMMARIES**

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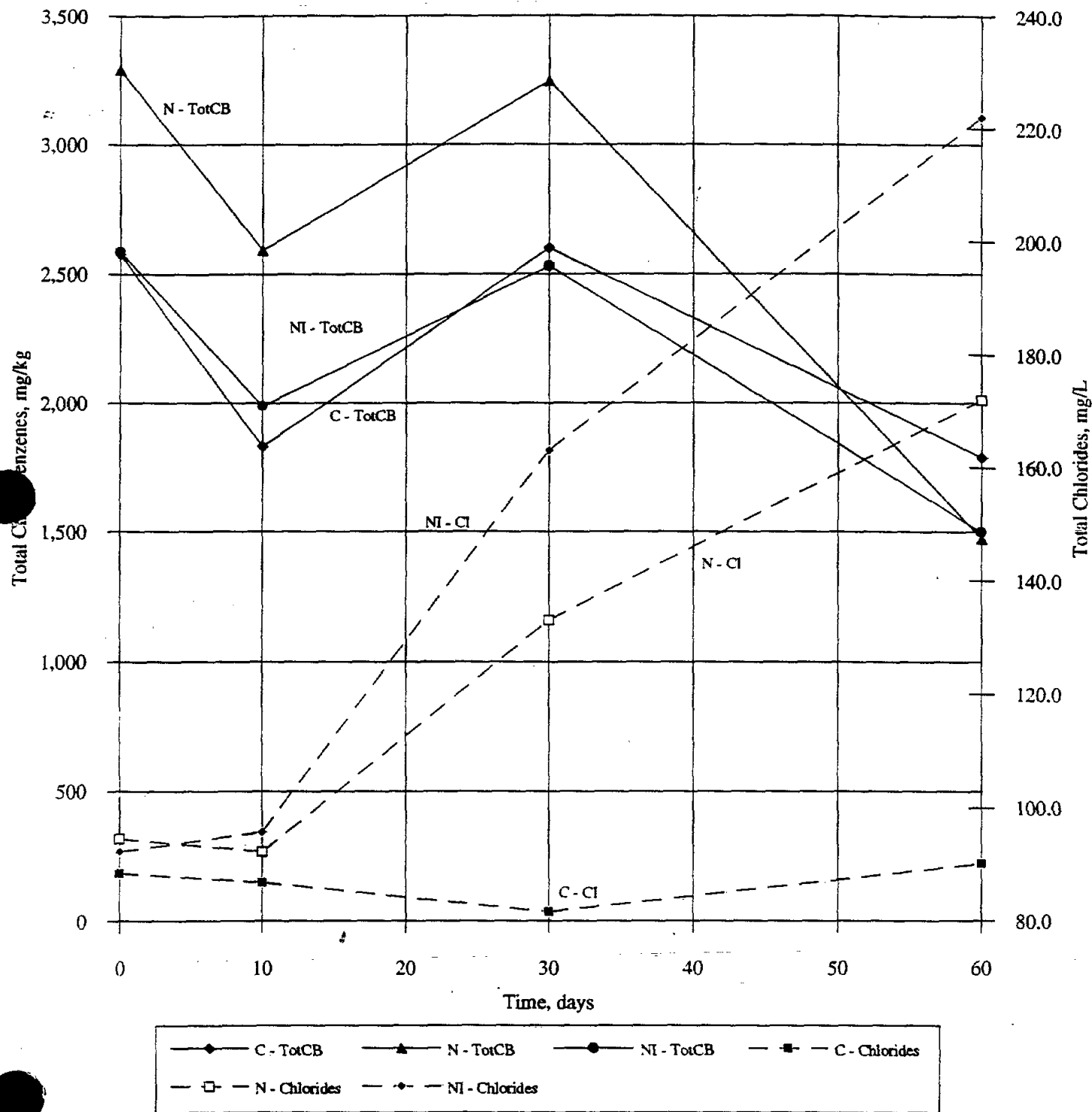
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**Figure 2**  
**SURFACE SOIL - AEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**



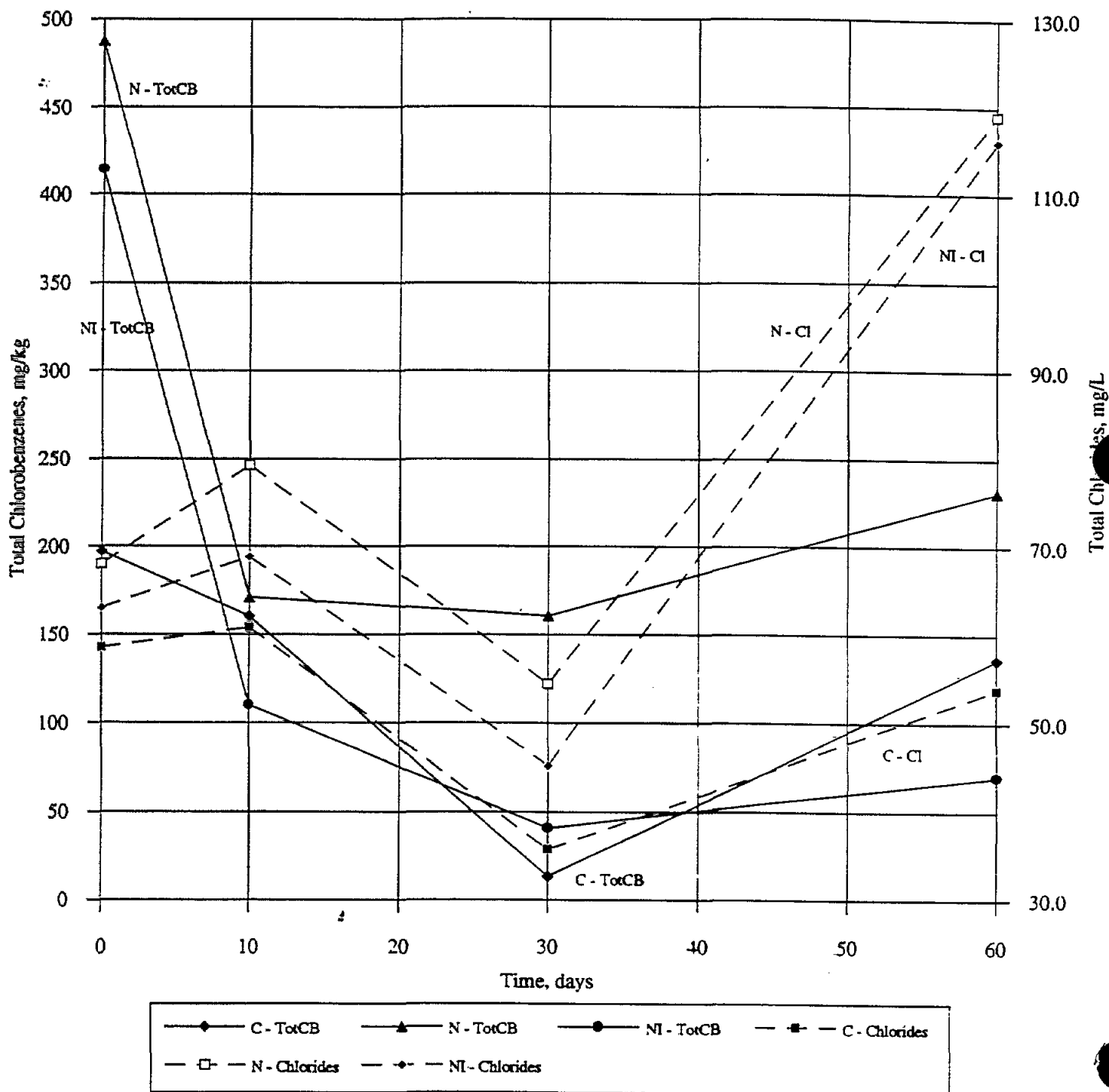
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**Figure 3**  
**SURFACE SOIL - ANAEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**



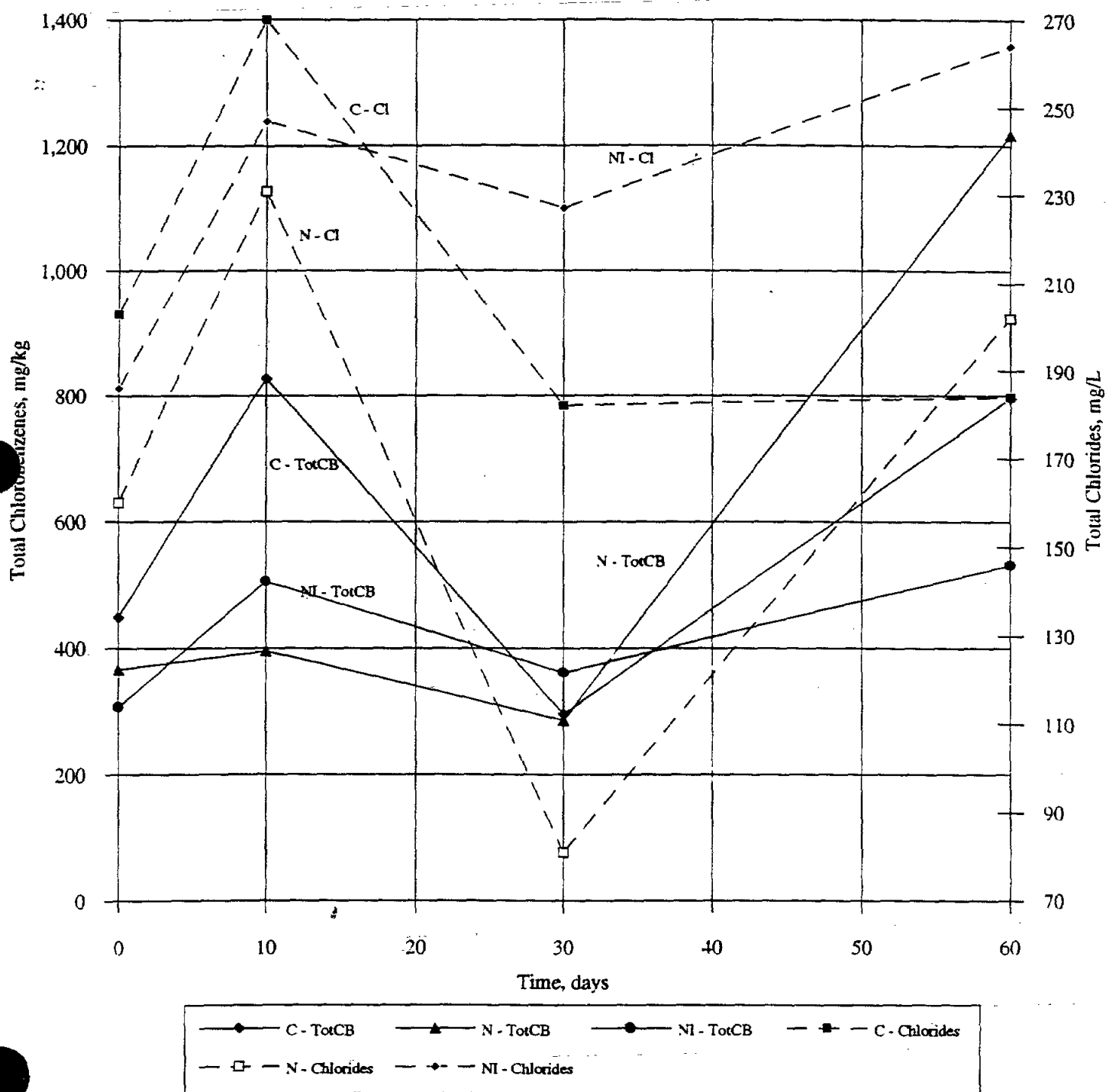
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**Figure 4**  
**SUBSURFACE SOIL - AEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**



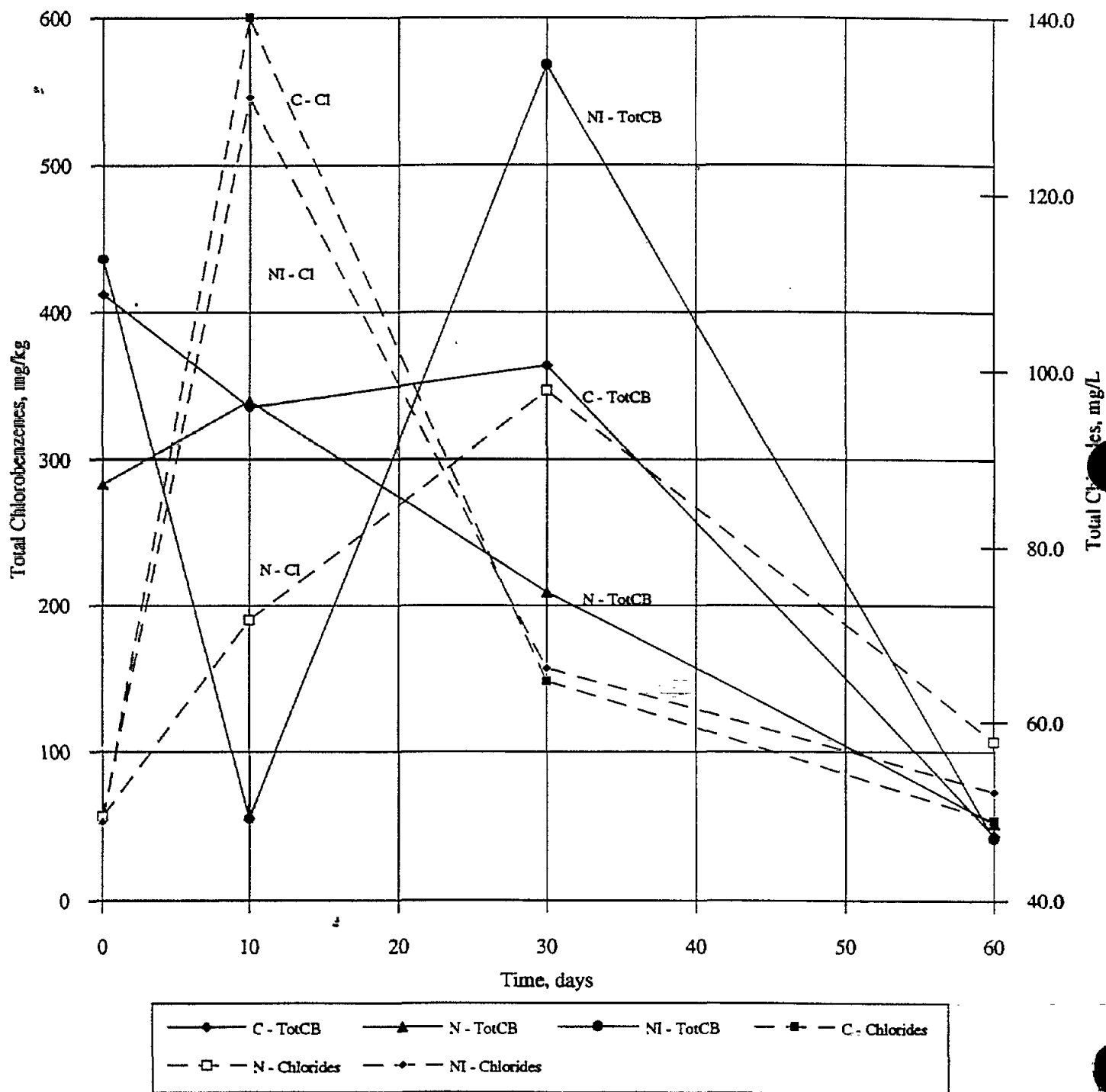
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**Figure 5**  
**SUBSURFACE SOIL - ANAEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**



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**Figure 6**  
**SEDIMENT - AEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**



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**Figure 7**  
**SEDIMENT - ANAEROBIC**  
**Total Chlorobenzenes and Total Chlorides vs. Time**

